

**Intrinsic Channel Properties, Scattering Mechanisms, Quantum Transport Properties in  
Transition Metal Dichalcogenides**

by

**Kraig Andrews**

DISSERTATION

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# List of Symbols

| Symbol             | Description            | Unit                                      |
|--------------------|------------------------|---|
| $\mathbf{A}$       | vector potential       | $\text{V s m}^{-1}$                       |
| $A$                | area                   | $\text{cm}^2$                             |
| $A^*$              | Richardson's constant  | $\text{A s}^{-1} \text{K}^2$              |
| $B$                | magnetic field         | T   |
| $C$                | capacitance            | F   |
| $E$                | electric field         | $\text{V m}^{-1}$                         |
| $E$                | energy                 | eV (J)                                    |
| $E_{\text{F}}$     | Fermi energy           | eV  |
| $E_g$              | bandgap energy         | eV  |
| $\hat{\mathbf{H}}$ | Hamiltonian            | eV (joule)                                |
| $I$                | current                | A   |
| $I_{\text{ds}}$    | drain current          | A   |
| $L$                | length                 | $\mu\text{m}$                             |
| $L$                | channel length         | $\mu\text{m}$                             |
| $m$                | mass                   | kg  |
| $m^*$              | effective mass         | kg  |
| $n$                | carrier density        | $\text{cm}^{-2}$                          |
| $n$                | charge carrier density | $\text{C cm}^{-2}$                        |
| $\hat{\mathbf{p}}$ | momentum operator      | $\text{kg m s}^{-1}$                      |
| $R$                | resistance             | $\text{k}\Omega \mu\text{m}$ ( $\Omega$ ) |
| $R_c$              | contact resistance     | $\text{k}\Omega \mu\text{m}$              |
| $R_H$              | Hall coefficient       | $\text{m}^3 \text{C}^{-1}$                |
| $\hat{\mathbf{s}}$ | spin operator          | $\hbar$ (J s)                             |

|                    |                                 |   |
|--------------------|---------------------------------|---|
| $T$                | temperature                     | K   |
| $V$                | voltage                         | V   |
| $V_{\text{bg}}$    | backgate voltage                | V   |
| $V_{\text{ds}}$    | drain voltage                   | V   |
| $V_{\text{H}}$     | Hall voltage                    | V   |
| $w$                | channel width                   | $\mu\text{m}$                             |
| $\mu$              | mobility                        | $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ |
| $\mu_{\text{B}}$   | magnetic moment                 | $\text{eV T}^{-1}$                        |
| $\mu_e$            | electron mobility               | $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ |
| $\mu_{\text{FE}}$  | field-effect mobility           | $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ |
| $\mu_{\text{H}}$   | Hall mobility                   | $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ |
| $\mu_p$            | hole mobility                   | $\text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ |
| $\rho$             | resistivity                     | $\Omega \text{cm}$                        |
| $\rho_{xx}$        | longitudinal resistivity        | $\Omega$                                  |
| $\rho_{xy}$        | transverse resistivity          | $\Omega$                                  |
| $\sigma$           | conductivity                    | $\mu\text{S}$                             |
| $\sigma_{xx}$      | longitudinal conductivity       | $\mu\text{S}$                             |
| $\sigma_{xy}$      | transverse conductivity         | $\mu\text{S}$                             |
| $\tau$             | scattering time                 | s   |
| $\tau_{\text{q}}$  | quantum scattering time         | s   |
| $\Phi_{\text{B}}$  | barrier height                  | eV  |
| $\Phi_{\text{B}n}$ | electron barrier height         | eV  |
| $\Phi_{\text{B}p}$ | hole barrier height             | eV  |
| $\Phi_{\text{M}}$  | metal work function             | eV  |
| $\Phi_{\text{S}}$  | semiconductor work function     | eV  |
| $\chi$             | electron affinity               | eV  |
| $\chi_{\text{S}}$  | semiconductor electron affinity | eV  |
| $\omega_c$         | cyclotron frequency             | Hz  |

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# List of Physical Constants

| Symbol       | Quantity                  | Value  |
|--------------|---------------------------|--|
| $k_B$        | Boltzmann's constant      | $1.380\,66 \times 10^{-23} \text{ J K}^{-1}$<br>$8.617\,34 \times 10^{-5} \text{ eV K}^{-1}$                                   |
| $\epsilon_0$ | dielectric constant       | $8.854\,18 \times 10^{-12} \text{ A}^2 \text{ s}^4 \text{ kg}^{-1} \text{ m}^{-3}$   |
| $e$          | elementary charge         | $1.602\,18 \times 10^{-19} \text{ C}$  |
| eV           | electron volt             | $1.602\,18 \times 10^{-19} \text{ J}$  |
| $c$          | speed of light            | $2.997\,92 \times 10^8 \text{ m s}^{-1}$   |
| $h$          | Planck's constant         | $6.626\,07 \times 10^{-34} \text{ J s}$  |
| $\hbar$      | reduced Planck's constant | $1.054\,57 \times 10^{-34} \text{ J s } (h/2\pi)$  |
| $R_{K-90}$   | von Klitzing constant     | $25\,812.807\,455\,55 \, \Omega$   |
| $m_e$        | electron mass             | $9.109\,383 \times 10^{-31} \text{ kg}$  |
| $k_B T$      | Thermal energy            | $0.025\,86 \text{ eV } (T = 27^\circ \text{C})$<br>$0.025\,26 \text{ eV } (T = 20^\circ \text{C})$                             |
| $\mu_B$      | Bohr magneton             | $9.274\,009 \times 10^{-24} \text{ J T}^{-1}$<br>$5.788\,381 \times 10^{-5} \text{ eV T}^{-1}$<br>$e\hbar/2m_e$ (atomic units) |

*Source:* CODATA Recommended Values of the Fundamental Physics Constants: 2014, Mohr *et al.*<sup>?</sup>

# Acronyms